

**Study Guide**

For use with pages 199–203

**GOAL** Work with negative and zero exponents.**EXAMPLE 1** Powers with Negative and Zero Exponents

Write the expression using only positive exponents.

$$\text{a. } 6^{-8} = \frac{1}{6^8} \quad \text{Definition of negative exponent}$$

$$\begin{aligned} \text{b. } x^0 h^{-5} &= 1 \cdot h^{-5} && \text{Definition of zero exponent} \\ &= \frac{1}{h^5} && \text{Definition of negative exponent} \end{aligned}$$

$$\text{c. } 4y^3 z^{-7} = \frac{4y^3}{z^7} \quad \text{Definition of negative exponent}$$

**Exercises for Example 1**

Write the expression using only positive exponents.

$$\begin{array}{llll} 1. 7^{-1} & 2. 157^0 & 3. 6x^0 y^{-2} & 4. s^{-11} t^{-1} \end{array}$$

**EXAMPLE 2** Rewriting Fractions

Write the expression without using a fraction bar.

$$\text{a. } \frac{1}{27} \qquad \text{b. } \frac{x^8}{y^{17}}$$

**Solution**

$$\begin{aligned} \text{a. } \frac{1}{27} &= \frac{1}{3^3} && \text{Write prime factorization of 27.} \\ &= 3^{-3} && \text{Definition of negative exponent} \end{aligned}$$

$$\text{b. } \frac{x^8}{y^{17}} = x^8 y^{-17} \quad \text{Definition of negative exponent}$$

**Exercises for Example 2**

Write the expression without using a fraction bar.

$$\begin{array}{llll} 5. \frac{1}{64} & 6. \frac{1}{100} & 7. \frac{g^5}{h^2} & 8. \frac{c^4}{d^4} \end{array}$$

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**EXAMPLE 3 Using Powers Properties with Negative Exponents**

Find the product or quotient. Write your answer using only positive exponents.

a.  $10^{19} \cdot 10^{-23}$

b.  $\frac{5x^{12}}{x^{14}}$

**Solution**

$$\begin{aligned} \text{a. } 10^{19} \cdot 10^{-23} &= 10^{19 + (-23)} \\ &= 10^{-4} \\ &= \frac{1}{10^4} \end{aligned}$$

Product of powers property

Add exponents.

Definition of negative exponent

$$\begin{aligned} \text{b. } \frac{5x^{12}}{x^{14}} &= 5x^{12 - 14} \\ &= 5x^{-2} \\ &= \frac{5}{x^2} \end{aligned}$$

Quotient of powers property

Subtract exponents.

Definition of negative exponent

**Exercises for Example 3**

Find the product or quotient. Write your answer using only positive exponents.

9.  $4^{-9} \cdot 4^{17}$

10.  $7^{-4} \cdot 7^{-11}$

11.  $\frac{k^{-12}}{k^{19}}$

12.  $\frac{t^{15}}{t^{-9}}$

**EXAMPLE 4 Solving Problems Involving Negative Exponents**

The radius of a proton is about 1000 attometers. An attometer is  $10^{-9}$  nanometer. What is the radius of a proton in nanometers?

**Solution**

To find the radius of a proton in nanometers, multiply the radius of a proton in attometers by the number of nanometers in one attometer.

$$\begin{aligned} 1000 \cdot 10^{-9} &= 10^3 \cdot 10^{-9} \\ &= 10^{3 + (-9)} \\ &= 10^{-6} \\ &= \frac{1}{10^6} \\ &= \frac{1}{1,000,000} \end{aligned}$$

Rewrite 1000 as  $10^3$ .

Product of powers property

Add exponents.

Definition of negative exponent

Evaluate power.

**Answer:** The radius of a proton is about  $\frac{1}{1,000,000}$  nanometer.